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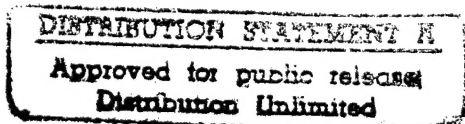
COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS AND INTELLIGENCE  
(C<sup>4</sup>I) IN REVOLUTION


by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.



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Abstract of  
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Command, Control, Communications, Computers and Intelligence (C<sup>4</sup>I) community has been in the midst of a revolution since the onset of DESERT SHIELD/DESERT STORM. Using multimedia, real-time, fully integrated command and control, this revolution seeks to exploit the adversary's command and control and operate within their decision cycle. This race has no limits in leveraging commercial technologies and services, international commercial data protocol standards and the latest innovations in information transfer technology. It also appears to have no pause for reassessment and course correction of the strategy along the way. The focus is on the opportunities, which do abound, with a lackluster appreciation for the inherent risks associated with being on the cutting edge of technology. The Warfighter needs to stay engaged to ensure he retains the capability to command and control his forces during the transitional phase of this C<sup>4</sup>I revolution and into the future. Pushing the technological envelope to provide a force multiplier to compensate for reductions in personnel, funding, weapons and information infrastructure must be balanced with the continued operation of the present (legacy) communications systems to provide a safety net for deployed forces. Reduction of systems acquisition cost and the drive to exploit technology will continue to set the C<sup>4</sup>I revolution but there needs to be a check and balance to ensure that the anticipated savings are real and that the deployed Warfighter is not left stranded while the NCA, the pentagon, CINC headquarters and fixed installations ride the information superhighway.

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## Introduction

*We have crossed the threshold of the Information Age—  
an age in which the pace of progress in all fields of human  
knowledge is hastening forward. The impact of this  
revolution will be experienced worldwide, presenting both  
risks and opportunities.*

US Navy, *Copernicus*<sup>1</sup>

This quotation captures the essence of the revolution within the Command, Control, Communications, Computers and Intelligence (C<sup>4</sup>I) community since the onset of DESERT SHIELD/DESERT STORM. Hastening pell-mell toward the 21st century and the achievement of military success by using multimedia, real-time, fully integrated command and control, this revolution seeks to exploit the adversary's command and control and operate within their decision cycle. This race has no limits in leveraging commercial technologies and services, international commercial data protocol standards and the latest innovations in information transfer technology. It also appears to have no pause for reassessment and course correction of the strategy along the way. The focus is on the opportunities, which do abound, with a lackluster appreciation for the inherent risks associated with being on the cutting edge of technology. This paper will examine the path that C<sup>4</sup>I has traveled since DESERT STORM and

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<sup>1</sup>Chairman, Joint Chiefs of Staff, C<sup>4</sup>I for the Warrior: Global Command & Control System (Washington: June 12, 1994), 4.

discuss critical areas of concern that the Warfighter needs to assess to ensure he retains the capability to command and control his forces during the transitional phase of this C<sup>4</sup>I revolution and into the future.

### Why the C<sup>4</sup>I Revolution?

DESERT STORM was a watershed event for the C<sup>4</sup>I arena. The myriad of problems experienced during that operation forced innovative thinking and policy changes from the top down. Of particular concern was the lack of interoperability between U.S. military communications systems with promulgation of the Air Tasking Order (ATO) being the most blatant example of interoperability failure. The incompatibilities between the Navy and Air Force systems forced the delivery of the ATO to the carriers by helicopter or S-3 rather than by communications systems. In 1991, based upon the lessons learned from URGENT FURY, JUST CAUSE and DESERT SHIELD/DESERT STORM, General Colin Powell tasked his J6 to address continuing issues of interoperability. General Powell reported to the Senate Armed Services Committee on May 10, 1992 that

*We are doing a lot on a program we have just started called C<sup>4</sup>I for the Warrior. Under my J6, Admiral Macke, we are taking a total look at the communications and intelligence systems that we are purchasing for the future to make sure that they are interoperable, to make sure that they have translation devices so every Service can talk to every other Service and so every unit of the battlefield can talk to every other unit on the battlefield.<sup>2</sup>*

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<sup>2</sup> Chairman, Joint Chiefs of Staff, C<sup>4</sup>I for the Warrior (Washington: June 12, 1992), 2.

The C<sup>4</sup>I for the Warrior concept began being institutionalized in strategy, policy and doctrine at the DoD level in 1992 and is reflected in the current National Military Strategy as the "Common View of the Battle" concept.<sup>3</sup> Secretary Perry again refined the C<sup>4</sup>I for the Warrior vision in 1995 as

*Efficient and interoperable information systems enable warfighting commanders to establish and maintain information dominance. Information for the warfighter must be integrated in a secure, seamless manner to the theater and ultimately the warrior's battlespace.<sup>4</sup>*

The key phrase in this quotation is "*ultimately [to] the warrior's battlespace.*" A primary concern, an inherent risk, is the impact on the Warfighter's operational planning while awaiting the arrival of integrated, secure and seamless information to the tactical battlefield. As will be discussed later in the paper, there is reason for the Warfighter to be concerned.

### The Path of the C<sup>4</sup>I Revolution

Several factors influenced the path toward which the C<sup>4</sup>I revolution gravitated. The first was time. The criticality of the near collapse of C<sup>4</sup> systems during DESERT SHIELD, particularly Naval communications systems, precipitated a sense of urgency to find a solution. The lack of interoperability adversely affected sharing and dissemination of intelligence products to the tactical level of operations as well as message communications. Had Saddam

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<sup>3</sup> Chairman, Joint Chiefs of Staff, National Military Strategy of the United States of America 1995 ((Washington: 1995), 15.

<sup>4</sup> William J. Perry, Secretary of Defense, Annual Report to the President and Congress (Washington: February 1995), 268.

Hussein targeted our information systems, he could have seriously affected our decision cycle and achieved some measure of tactical success. Since we attempt to develop lessons learned and correct weaknesses we can only assume our potential adversaries also learn from our operations and develop strategies and tactics to exploit our demonstrated weaknesses. The problem of interoperability is not new, having plagued our joint operations significantly since operation URGENT FURY. DESSERT STORM ignited a sense of urgency and time became the critical driver in solving the interoperability problem thereby driving the future path of the C<sup>4</sup>I revolution.

Money limited the options. The budget reductions of the nineties placed significant constraints on possible solutions. Wholesale replacement of service and function unique (stovepipe) communications systems would have cost in the billions. Most systems involved proprietary software that belonged to the developer vice the government and were costly to modify. The quick fix solution was to create translators to act as interface devices between systems. The Joint Universal Data Interpreter was successfully developed and demonstrated and became the basis for a migration strategy from expensive, proprietary software, stovepipe systems toward innovative, flexible, commercial off-the-shelf software and hardware based on standardized protocols.<sup>5</sup>

Politics also played a major role in choosing the C<sup>4</sup>I revolution path. In 1991, The White House issued National Space Policy Directive 3 directing the

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<sup>5</sup> C<sup>4</sup>I for the Warrior: Global Command & Control System, 4-6.

use of commercially available space products and service "to the fullest extent possible."<sup>6</sup> With the change of administration in 1993, this commercialization philosophy concerning how the government would interact with the private sector was strengthened. Vice President Gore provided additional impetus through his Reinventing Government initiative. The emphasis on reinventing government and reliance upon the private sector (outsourcing) and downsizing government became the driving force behind acquisition and architecture decisions. The Clinton administration discontinued the National Space Council, previously headed by Vice President Quayle. The National Space Council developed integrated government policies on development of space infrastructure including replacing the aging government owned and operated launch facilities. The new policy called for reducing government involvement and fostering private development of space capabilities. The guidance provided to DoD emphasized outsourcing of all services (telecommunications included) which private enterprise could accomplish without endangering national security. The focus on telecommunications requirements ranged from base and long distance telephone service to general purpose (low survivability required) satellite requirements.<sup>7</sup>

Downsizing of the DoD provided another constraint in the strategy decision for the future C<sup>4</sup>I capability. Military specified development, owned, operated and

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<sup>6</sup> U.S. General Accounting Office, Military Satellite Communications: DoD Needs to Review Requirements and Strengthen Leasing Practices. Report to the Chairman, Subcommittee on Defense, Committee on Appropriations, House of Representatives (Washington, 1994), 1.

<sup>7</sup> Chairman, Joint Chiefs of Staff, Military Satellite Communications Systems, CJCS MOP 37 (Washington, 1992), A-4.

maintained C<sup>4</sup>I systems are manpower intensive. Additionally, the government procurement process involves a procurement cycle from four to seven years for information systems. This is not responsive in a technology driven environment that makes generational technology jumps every 18 months. Staying within the old paradigm of only purchasing communications hardware and software developed and written to military specifications would cause the fielding of equipment technically inferior to what the average U.S. consumer could purchase and, more significantly, what our potential adversaries could purchase on the commercial market.

Last among the significant factors influencing the path chosen was the state of the telecommunications infrastructure. Current military communications satellites, except UHF Follow-On, have reached or exceeded their life expectancy. Replacements are extremely expensive to build, launch and operate and the launch infrastructure is based on recycled missiles principally the Titan and Atlas series. These launch vehicles are ill-equipped to perform state of the art boost yet have not been replaced by any launch vehicle designed specifically for placing satellites into orbit. Additional infrastructure cost of upgrading copper wire base cable plants to fiber optics provide another disincentive to retaining military operation and maintenance responsibility vice contracting services from commercial vendors. Given the problems with money, politics, technological realities, infrastructure and manpower reductions, transitioning to the commercial sector provided the only viable course of action for the C<sup>4</sup>I revolution.

## Current Status of C<sup>4</sup>I Technology Revolution

There are several initiatives underway today to bring integrated, secure and seamless information to the tactical battlefield. The principal technological focus is presented in the Global Grid concept.

*Global grid is defined as the totality of all information systems and communications systems that span the globe. The objective of the global grid is to facilitate the communications (data, voice and video) at any time to anybody, and from anywhere throughout the world.<sup>8</sup>*

The Joint Staff view of this concept is to use fiber optics to implement the global network. Use of terrestrial fiber optics would enable the reduction of transmissions across military satellite systems, principally for fixed site installations. These terrestrial fiber cables will carry the load of theater C<sup>4</sup>I connectivity. This migration would reduce the loading on the space segment for use by the deployed forces unable to connect with fiber optics and for meeting expanding satellite requirements with required a high degree of survivability and security (hard core requirements as defined by CJCS MOP 37). Fiber optics would also provide seamless "reachback" to the continental United States for the Joint Task Force (JTF) connecting the JTF with its home base.<sup>9</sup> The extent of fiber optic cable networks throughout the world is proportional to the level of each region's industrialization. Fiber optics is the media of choice because of its typical

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<sup>8</sup> Ram Voruganti, Bill Fonseca, and William Gex, "Impact of Satellite Delay on Protocol Performance for ATM Traffic over Non-Processing Satellites," Paper Presented at 1994 Institute of Electrical and Electronics Engineer MILCOM Conference, 68.

<sup>9</sup> LTC Neil L. Putz, USA, "Global Grid: Opportunity for Information Supremacy through Fiber Optics," Joint Staff J6T Briefing, (Washington, 1996), 4.

Bit Error Rate (BER) of  $10^{-9}$  to  $10^{-12}$ .<sup>10</sup> This virtually noise free transmission is needed to utilize Asynchronous Transfer Mode (ATM) transmission and switching technology supporting Broadband Integrated Services Network. ATM is the transmission technology of choice because it provides efficient use of bandwidth through multiplexing and transmitting at 45 to 622 Mbps.<sup>11</sup> In comparison, a Tactical Satellite Channel provides 16 Kbps.<sup>12</sup> This technology is being developed very rapidly on the commercial market to meet corporate requirements. The principal distinguishing characteristic for the corporate implementation of ATM is that they do not require mobility in the same manner the military requires it on the tactical battlefield, which is usually deprived of technologically advanced communications infrastructure.

A second initiative is Mobile Satellite Services (MSS). The draft Operational Requirements Document (ORD) states:

*The envisioned MSS service will provide global real-time voice, paging, facsimile, and data services.*<sup>13</sup>

This ORD identifies a requirement for space-based cellular service for the tactical environment. In comparison to ATM, this requirement is a low tech leveraging of commercial capability. Envisioned for use in disaster relief, combat

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<sup>10</sup> Dr. Donald L. Hagen and Timothy T. Piper, "ATM for Disadvantaged Tactical Links," Paper Presented at 1994 Institute of Electrical and Electronics Engineer MILCOM Conference, 73.

<sup>11</sup> Ibid.

<sup>12</sup> Charles Graff, Frank Halloran and Clayton Lockhart, "Tactical Battlefield ATM", Paper Presented at 1994 Institute of Electrical and Electronics Engineer MILCOM Conference, 475.

<sup>13</sup> Draft Operational Requirements Document for Mobile Satellite Services, 26 April 1996, 1.

survivor and evader location, polar communications, VIP activities and Special Operations Force missions, the advantages of MSS will be increased mobility, minimal set-up time, significantly reduced logistical cost and increased communications range. The requirements for the system focus on interoperability requiring MSS to interface with STU-III, Defense Information Systems Network, Defense Red Switch Network (DRSN), the Public Switched Telephone Network (PSN) and the tactical internet.

A possible bidder to the approved MSS ORD may well be Orbital Communications Corporation. This commercial enterprise is marketing to the military for "... two-way on-the-move data messaging anywhere in the world. . . using low-Earth orbit (LEO) satellites instead of terrestrial fixed site relays or repeaters to provide worldwide geographic coverage."<sup>14</sup> Other commercial enterprises have been initiated to provide world-wide satellite cellular telephone services and more competition can be expected in the future. These commercial initiatives validate the intent of the National Space Policy Directive 3 calling for the expansion of opportunities for private enterprise to compete in providing space products for use by the military.

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<sup>14</sup> Todd Hara, "ORBCOMM PCS Available Now!", Paper Presented at 1995 Institute of Electrical and Electronics Engineer MILCOM Conference, 874.

## The Inherent Risks

Leveraging off rapidly developing commercial information technology provides immense benefits to the fixed installation portion of the military infrastructure. Certainly, the high speed, multimedia capability permits the realization of the integrated, secure, seamless battlespace. Areas for concern do exist. Corporations are not developing the explosion of commercial satellite capability exclusively for military use. A rapidly increasing demand for satellite services exists in industrialized and developing nations. In this environment the availability of commercial satellite capacity for military use for a Major Regional Conflict, time critical contingency operation or Military Operation Other than War is questionable. These systems do not currently have precedence or priority capability. Although, the Federal Communications Commission is expected to approve a priority and precedence scheme for commercial systems within the next year<sup>15</sup>, that would only affect U.S. systems. Most burgeoning space systems are expected to be owned and operated by multinational corporations or consortiums similar to INTELSAT.

One of the greatest risks is assessing the impact on the Warfighter when the C<sup>4</sup>I system he expects to use for command and control of an operation are not available because commercial activities have previous claims or leases for the access or the adversary has purchased all the available bandwidth to deny U.S. forces access. Another possible scenario is that the consortium who owns

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<sup>15</sup> Telephone Conversation with LTC Neil L. Putz, Joint Staff C4 Directorate Defense-Wide Networks Division Action Officer, Washington, DC, 15 May 1996.

and operates the only available satellite resource in the area opposes the use of their asset by U.S. military forces. No mechanism exists under international law to nationalize or seize an international asset for United Nations use in a crisis scenario.

***Ensure Spectrum Supremacy - Unrestricted access to the spectrum is critical to: the Warfighters' ability to see the battlefield through a variety of sensors; . . . and the commander's ability to communicate their intent. Providing the Warfighter electromagnetic spectrum supremacy will maximize the benefits of maneuver and tempo.<sup>16</sup>***

This maxim is in jeopardy when the availability of commercial bandwidth is in question.

Another inherent risk involves the quote from earlier in the paper -  
". . . Information for the warfighter must be integrated in a secure, seamless manner to the theater and ultimately the warrior's battlespace." (Emphasis added) ATM technology is not deliverable to the tactical battlefield today. The high BER (in comparison to fiber optics) of tactical satellites and tropospheric microwave (line of sight) communications do not permit reliable ATM transmission. Many different engineering organizations are actively developing strategies to overcome this technological obstacle. In the interim, a potential for a have (fixed infrastructure) and have not (deployed force) dichotomy exists. The Warfighter faces not having the information tools available that he has

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<sup>16</sup> R. B. Mouldin and P.A. Young, "Wireless Battlefield Tactical Networking Supporting C2OTM and C<sup>4</sup>I for the Army Warrior", Paper Presented at 1994 Institute of Electrical and Electronics Engineer MILCOM Conference, 183.

become dependent upon. This occurred during DESERT SHIELD when General Schwarzkopf arrived in Saudi Arabia and demanded that his operations center have the same equipment as he was accustomed to using in Tampa, Florida, specifically DRSN access.

The current plan of action calls for the migration of land based, fixed communications from military satellite transmission paths to terrestrial fiber optic transmission paths. This is expected to enable the tactical battlefield to use the released satellite bandwidth capacity to increase the flow of information using current communications systems. Although this presents a logical strategy, a review of the large capacity users of military Super High Frequency satellite bandwidth will reveal that their priority for access exceeds the JTF C<sup>2</sup> priority. Further complicating this strategy is that these large capacity user requirements necessitate high survivability and security as defined by CJCS MOP 37. Transitioning their requirements to terrestrial fiber optics will not meet the national security and survivability requirements of their data. Therefore, the quantity of SHF bandwidth released by utilizing fiber optics may not be significant enough to provide a seamless, integrated view of the battlefield to the Warfighter. Another alternative considered by the Joint Staff is the deployment of fiber optic cable to the underdeveloped communications operating area to provide the capability to access the ATM environment. This would entail air lifting fiber optics cable to the region and extending the existing fiber cable

network into such places as Mogadishu, Somalia prior to initiating operations.<sup>17</sup>

The questions concerning how long this would take, who would perform the work (None of the services have retained the capability to run communications cable in the active or reserve components), or the impact on the strained airlift capacity must all be considered by the Warfighter in his campaign plans and courses of action.

Security is another concern to be faced in this commercial environment.

*Any Government service which transits or resides on PSN facilities is vulnerable to the same sort of electronic intrusion threats faced by non-Government services. Threats from service disruption, denial of service, unauthorized disclosure of data, unauthorized modification of service, and fraud are present in the PSN and should be considered when making contingency and emergency service plans.*<sup>18</sup>

Fiber optic networks are a part of the PSN. Utilization of this capability must be considered at greater risk than military legacy systems which are under military control endpoint-to-endpoint. This can be an exploitable situation for a technologically adept adversary or an adversary who can afford to buy the technology.

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<sup>17</sup> Telephone Conversation with LTC Putz.

<sup>18</sup> Dr. Joe Frizzell, Ted Phillips, and Traigh Groover, "The Electronic Intrusion Threat to National Security and Emergency Preparedness Telecommunications." Paper Presented at 1994 Institute of Electrical and Electronics Engineer MILCOM Conference, 564.

## Recommendations

There are several actions the Warfighter can take to manage the chaos of opportunities and inherent risk involved in surviving the C<sup>4</sup>I revolution. First and foremost, the Warfighter must never assume that communications will be there when he needs them. He must direct his J6 staff to stay actively engaged in understanding the progress of the information technology revolution, the status of military and commercial communications assets in his area of responsibility and the political and economic possibilities of being able to utilize those capabilities in hostile and emergency environments. The J6 staff must be prepared to prioritize their communications requirements should their operating environment not permit robust communications. Communications exercises must be conducted among the forces to ensure that the capability to operate within a deprived communications environment is not lost. Lastly, using the Integrated Priority List, the Warfighter must be prepared to prioritize his C<sup>4</sup>I infrastructure among his requirements for ships, planes, tanks, weapons and people.

*Now the Army, Navy, and Air Force, generally speaking, want to buy, respectively, tanks, ships, and airplanes. They aren't all that enthused about spending a lot of money on the Defense Communications System . . .*<sup>19</sup>

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<sup>19</sup> Thomas P. Coakley, ed., C<sup>3</sup>I: Issues of Command and Control. (Washington: National Defense University Press, 1991), 169. Quote attributed to Lee Paschall, C<sup>3</sup>I and the National Military Command System.

## **Conclusions**

The age of information is here. The drive is to push the technological envelope to provide a force multiplier to compensate for reductions in personnel, funding, weapons and information infrastructure. The balance must be to ensure the continued operation of the present (legacy) communications systems as the deployed forces safety net needed to compensate for being on the leading edge of information technology. Reduction of systems acquisition cost and the drive to exploit technology will continue to set the C<sup>4</sup>I revolution but there needs to be a check and balance to ensure that the anticipated savings are real and that the deployed Warfighter is not left stranded while the NCA, the pentagon, CINC headquarters and fixed installations ride the information superhighway.

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